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A GLIMPSE ON THE SHIFT IN RESEARCH FOCUS AT IICB (1940-2010)

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Abstract

The study has tried to evaluate the shift in research focus carried out at IICB during the period 1940 to 2010. In this study, the growth has been observed in terms of publications, patents and Ph.D. theses. During its long journey, IICB published 3570 publications, filed 242 patents and 552 Ph.Ds. supervised. The scholarly outputs have been recorded and categorized based on the diseases focus undertaken for research and assessed the shift in research focus. Zipf's law has not been found true in this study.

Keywords: Sceintometrics; Research focus;

Introduction

Indian Institute of Chemical Biology (IICB) was established in the name of Indian Institute for Medical Research on 1st January in the year 1935. The Institute came under CSIR in April 1956 as the "Indian Institute for Biochemistry and Experimental Medicine". Later, Indian Institute of Experimental Medicine got a new name just by dropping the word "Biochemistry" from the earlier name "Indian Institute for Biochemistry and Experimental Medicine" given by the then Prime Minister of India, Shri Jawaharlal Nehru. Finally it was renamed as Indian Institute of Chemical Biology (IICB) in the year 1982. Presently, it comprises of seven R&D Divisions- Infectious Diseases and Immunology, Molecular & Human Genetics, Drug Development, Diagnostics & Biotechnology, Chemistry, Structural Biology & Bioinformatics, Cell Biology& Physiology and Cancer Biology & Inflammatory Disorder Division. The overall progress of the institute continues.

During its long journey, a total 3570 research publications were published during 1940 to 2010 by IICB in various sources. A total of 242 patents are recorded in patent profile of the

Institute since 1990 to 2010. 552 research scholars did their Ph.Ds. from IICB and achieved their doctorate degree from different Universities from 1968 to 2010.

The assessment of the dimension of research is a vital element of R&D institutions. These days, the development and use of analytical tools based on readily available quantitative information to help in decision-making processes in science became an important issue. The present study was undertaken to assess the shift in research focus of IICB on the basis of its scientific output.

Purpose of the study

Purpose of this work is to evaluate the productivity of institutional research and developmental activities. This research work/s tries to highlight the contribution of the institution in different areas of research and to assess the shift in research focus over the period of study during 1940-2010.

Methodology

IICB publications were downloaded from Web of Science (WOS) and supplemented by the records printed in Annual Reports published from time to time. The data retrieved from the WOS was retained as Note pad files and developed in to a database by importing the Note pad files through Fangorn utility software into CDS-ISIS. The data collected was retained in CDS-ISIS and Microsoft's Excel was used for further analyses and inferences were drawn.

Subject category was one of the best indicators to understand and grasp instantly the thought content of the publications and to find out the growth of the subject field. For that purpose, categories assigned by the indexer or the author himself helped in indentifying the specific areas where the growth of knowledge were considered. Title of the publications, author's keywords and sometimes abstract were also studied to find out the disease focus wherever possible and categorized accordingly. Finally, subject experts were consulted and 39 different subject categories were identified where IICB researchers contributed over the period of time.

ANALYSIS AND DISCUSSION

Chronological Growth of Publications

Research output of IICB in the form of research publications has been illustrated in Table 1. A total of 3570 papers were published during 1940-2010. During the years 1940 to 1950, the output was 31 in number of publications and in this period output was merely one except 1941. In 1941, 10 papers were published. From the year 1951 to 2002, the number of publications was less than 100, but as an exception, the Institute produced 103 publications in 1980. The average number of papers produced per year was 50.28. The highest number of publications produced was 166 in 2006 with an increase of 40.68% over the year 2005.

Increased trend in output was observed from 2001 to 2006 and a decreasing trend was found from 2007 to 2010 except 2008. In 2007, output was dropped by 13.25% compared to 2006.

Table 1. Year-wise output of IICB from 1940 to 2010

Year	NP*/ %	Year	NP*/ %	Year	NP*/ %	Year	NP*/ %
1940	1(0.03)	1960	26(0.73)	1977	53(1.48)	1994	80(2.24)
1941	10(0.28)	1961	36(1.01)	1978	66(1.85)	1995	71(1.99)
1942	6(0.17)	1962	22(0.62)	1979	50(1.40)	1996	74(2.07)
1943	1(0.03)	1963	22(0.62)	1980	103(2.89)	1997	95(2.66)
1944	2(0.06)	1964	5(0.14)	1981	76(2.13)	1998	70(1.96)
1945	2(0.06)	1965	10(0.28)	1982	76(2.13)	1999	95(2.66)
1947	2(0.06)	1966	9(0.25)	1983	64(1.79)	2000	81(2.27)
1948	1(0.03)	1967	19(0.53)	1984	87(2.44)	2001	78(2.18)
1949	6(0.17)	1968	21(0.59)	1985	66(1.85)	2002	82(2.30)
1951	5(0.14)	1969	24(0.67)	1986	74(2.07)	2003	101(2.83)
1953	1(0.03)	1970	25(0.70)	1987	83(2.32)	2004	103(2.89)
1954	1(0.03)	1971	24(0.67)	1988	75(2.10)	2005	118(3.31)
1955	10(0.28)	1972	28(0.78)	1989	57(1.60)	2006	166(4.65)
1956	22(0.62)	1973	31(0.87)	1990	70(1.96)	2007	144(4.03)
1957	27(0.76)	1974	34(0.95)	1991	72(2.02)	2008	156(4.37)
1958	19(0.53)	1975	34(0.95)	1992	73(2.04)	2009	140(3.92)
1959	18(0.50)	1976	50(1.40)	1993	77(2.16)	2010	140(3.92)

NP*=Number of papers / %= Percentage of paper published

Subject Areas of Research Focus

Table 2 depicted that the highest number of documents were published on 'Leishmania' with 441 (12.35%) publications. This table further shows that next preferred subject categories were; Natural Products Chemistry 370 (10.36%), Biochemistry and Molecular Biology 281 (7.87%), Cholera Research 277 (7.76%), Synthesis of New Chemical Entities 262 (7.34%), Drug Development and Discovery 236 (6.61%), Neurosciences 234 (6.55 %), Reproductive Biology 209 (5.85%), Biotechnology and Applied Microbiology 190 (5.32%), Cancer Research 175 (4.90 %), Biophysics and Structural Biology 151 (4.23%), Endocrinology and Metabolic Disorders 116 (3.25%) and Biological Research Methods 100 (2.80%).

Table 2. IICB research focus during 1940-2010

Area of Research	Number of publications	Percentage
Leishmania	441	12.35
Natural Products Chemistry	370	10.36
Cholera Research	277	7.76
Biochemistry and Molecular Biology	281	7.87
Drug Development and Discovery	236	6.61
Synthesis of New Chemical Entities	262	7.34
Reproductive Biology	209	5.85
Neurosciences	234	6.55
Cancer Research	175	4.90
Biotechnology and Applied Microbiology	190	5.32
Biophysics and Structural Biology	151	4.23
Endocrinology and Metabolic Disorders	116	3.25
Biological Research Methods	100	2.80
Computational Biology and Bioinformatics	66	1.85
Genetics and Heredity	65	1.82
Gastrointestinal Disorders	57	1.60
Library and Information Science	54	1.51
Inflammatory and Immunological Disorders	38	1.06
Nuclear Medicine	35	0.98
Infectious Diseases - Bacteriology	31	0.87
Other 19 Research area	182	5.10
Total	3570	100.00

Shift in Research Focus

Data was analyzed to assess the changing focus of the research activities done at IICB. The data of different blocks of five years were tabulated to achieve the objective. Therefore the results have been presented block-wise below in table 3.

During the period from 1940-50, out of 11 areas, focal area of research was Leishmania with 22.58% publications followed by Infectious Diseases- Malaria with 19.35%, Biochemistry and Molecular Biology with 16.13%, Infectious Diseases- Bacteriology 9.68%, Cholera Research, Infectious Diseases – Typhoid & Toxicology with 6.45% publications each out of total 31 publications. A change in research focus was observed in 1951-60, out of 129 publications, Biochemistry and Molecular Biology was most preferred area of research with 24.03% publications followed by Cholera Researchwith 13.18%, Biological Research Methods with 10.85%, Reproductive Biology 7.75% publications and Leishmania was at fifth position with 6.20% publications. During the years 1961-70, the main focus of research was on Cholera with 31.61% publications out of total 193 followed by Natural

Product Chemistry 19.17%, Biochemistry and Molecular Biology 9.33%, Drug Development and Discovery and Leishmania 7.77% publications by each. It is observed that during 1940 to 1970, IICB research emphasis had been shifting from one area to another.

In the next decade from 1971-80, Natural Product Chemistry with 21.78% was most attractive area for research followed by Drug Development and Discovery with 10.15%, Cholera Research 8.88%, Biochemistry and Molecular Biology & Reproductive Biology with 8.03 % each and Biotechnology and Applied Microbiology was at fifth position with 7.40% publications out of total 473 publications. Whereas, out of total 728 publications, Natural Product Chemistry attracted research focus as 14.01% published in this area, the second preferred area was Biochemistry and Molecular Biology with 13.60%, Cholera Research & Drug Development and Discovery with 8.79% publications each. Reproductive Biology was at fourth position with 8.38% and Leishmania was at fifth position with 7.01%. It was observed that there were 28 research areas during this decade of 1981-90 against 18 research areas in 1971-80.

During 1991-2000, out of 28 research areas in 788 publications, major focus was on Leishmania as 16.41% publications were published in this area followed by Natural Product Chemistry 11.70%, Synthesis of New Chemical Entities 9.03%, Biotechnology and Applied Microbiology 7.63% and Neurosciences was at fifth position with 7.25% publications. In the decade 2001-10, five preferred areas of research were Leishmania 18.16%, Synthesis of New Chemical Entities 8.96%, Cancer Research 8.22%, Neurosciences 8.14% and Biophysics and Structural Biology 7.65% out of total 31 different research areas in 1228 publications during this period.

Table 3. Shift in research focus in various blocks of years

	2001-2010	1991-2000	1981-1990	1971-1980	1961-1970	1951-1960	1940-1950
Leishmania	223	129	51	8	15	8	7
Synthesis of New Chemical Entities	110	71	49	24	4	4	
Cancer Research	101	34		22	5	4	
Neurosciences	100	57	45	26		6	
Biophysics & Structural Biology	94	28	20	9			
Drug Development and Discovery	72	32	64	48	15	4	1
Genetics and Heredity	55	10					
Biotechnology and Applied Microbiology	51	60	43	35		1	
Cholera Research	49	51	64	42	61	17	2
Computational Biology and Bioinformatics	45	19	2				
Reproductive Biology	44	43	61	38	11	10	
Biochemistry & Molecular Biology	41	49	99	38	18	31	5
Endocrinology and Metabolic Disorders	40	20	22	23	9	2	1

Natural Products chemistry	34	92	102	103	37	2	
Gastrointestinal Disorders	30	16	9			1	1
Toxicology - Arsenic	29						
Nonlinear dynamics	23	1		2			
Biological Research Methods	22	19	28	17		14	
Toxicology - Venom	16	6	2				
Inflammatory and Immunological Disorders	13	13	4	1	1	6	
Nuclear Medicine	12	13	11				
Infectious Disease- Malaria	7					2	6
Toxicology	6	6	9		1	3	2
Cardiovascular Disorders	4	1		3	8	1	
Biography	1	2	2				
Crystallography	1						
Infectious Diseases - Encephalitis	1						
Infectious Diseases - Leprosy	1				2	2	
Infectious Diseases - Tuberculosis	1	1				1	
Infectious Diseases- Bacteriology	1	8	9	6		5	3
Infectious Diseases- Virology	1		1				
Infectious Diseases - Typhoid							2
Infectious Diseases- Amebiasis					2	5	1
Infectious Diseases- Filaria		3	6				
Infectious Diseases- Gonorrhea			3				
Library and Information Science			22	28	4		
Multidisciplinary Sciences		2					
Total	1228	786	728	473	193	129	31

In case of patents, IICB filed 62 patents in Cholera research followed by 59 patents in Drug Development and Discovery, Leishmania with 30 patents, Reproductive Biology with 24 patents. Endocrinology and Metabolic Disorders was at fifth position with 14 patents out of total 242 patents. Though, Leishmania was at first position in case of publications and it was again preferred research area in 130 doctoral researches followed by Cholera research, 52 Reproductive Biology 40, Biochemistry and Molecular Biology, 38 and 36 in Synthesis of New Chemical Entities out of total 552 doctoral degrees.

Table 4. Preferred research area in patents and Ph.D. theses

Research area	Ph.D. theses	%	Patents	%
Leishmania	130	23.55	30	12.40
Natural Products Chemistry	31	5.62	7	2.89
Cholera Research	52	9.42	62	25.62
Biochemistry and Moleuclar Biology	38	6.88		

Drug Development and Discovery	18	3.26	59	24.38
Synthesis of New Chemical Entities	36	6.52	9	3.72
Reproductive Biology	40	7.25	24	9.92
Neurosciences	29	5.25	1	0.41
Cancer Research	31	5.62		
Biophysics and Structural Biology	31	5.62		
Endocrinology and Metabolic Disorders	16	2.90	14	5.79
Biological Research Methods	6	1.09	12	4.96
Computational Biology and Bioinformatics	14	2.54	1	0.41
Genetics and Heredity	10	1.81		
Gastrointestinal Disorders	16	2.90		
Library and Information Science	1	0.18		
Inflammatory and Immunological Disorders	4	0.72	10	4.13
Nuclear Medicine	9	1.63	6	2.48
Toxicology – Arsenic	7	1.27		
Applied Microbiology & Biotechnology	25	4.53	5	2.07
Toxicology – Venom	3	0.54	1	0.41
Cardiovascular Disorders	4	0.72		
Infectious Diseases- Leprosy			1	0.41
Infectious Disease- Gonorrhoeae	1	0.18		
Total	552	100.00	242	100.00

Zipf's Law of Word Occurrence

Law of word occurrence was developed by Zipf in 1949. Zipf developed and extended an empirical law, it represent a relation between the rank of a word and the frequency of its appearance in a text.

If r is the rank of a word and f is its frequency, then mathematically Zipf's law is rf= c, where 'c' is a constant

This law states that in a long textual matter, if words are arranged in their decreasing order of frequency, then the rank of any given word of the text will be inversely proportional to the frequency of the occurrence of the word. He found that by multiplying the numerical value of each rank (r) by its corresponding frequency (f), he obtained a product (c) which is constant throughout its text.

Test of Zipf's Law: Publications

Zipf's Law of Word Occurrence was applied with the occurrences of categories assigned to publications. According to this law by multiplying the numerical value of each rank (r) by its corresponding frequency (f), product (c) which was not constant as depicted in table below.

Table 5. Test of Zipf's Law on IICB Publications

Research Area	Rank (r)	Frequency (f)	Product (rf)= c
Leishmania	1	441	441
Natural Products Chemistry	2	370	740
Cholera Research	3	281	843
Biochemistry and Molecular Biology	4	277	1108
Drug Development and Discovery	5	262	1310
Synthesis of New Chemical Entities	6	236	1416
Reproductive Biology	7	234	1638
Neurosciences	8	209	1672
Cancer Research	9	190	1710
Biotechnology and Applied Microbiology	10	175	1750
Biophysics and Structural Biology	11	151	1661
Endocrinology and Metabolic Disorders	12	116	1392
Biological Research Methods	13	100	1300
Computational Biology and Bioinformatics	14	66	924
Genetics and Heredity	15	65	975
Gastrointestinal Disorders	16	57	912
Library and Information Science	17	54	918
Inflammatory and Immunological Disorders	18	38	684
Nuclear Medicine	19	35	665
Infectious Diseases - Bacteriology	20	31	620

Test of Zipf's Law: Ph.D. theses and Patents

Table 6. Test of Zipf's Law on Ph.D. theses and Patents from IICB

Research Area	Rank (r)	Frequency(f)	Product (rf)= c
Leishmania	1	601	601
Natural Products Chemistry	2	408	816
Cholera Research	3	391	1173
Biochemistry and Moleuclar Biology	4	319	1276
Drug Development and Discovery	5	313	1565
Synthesis of New Chemical Entities	6	307	1842
Reproductive Biology	7	273	1911
Neurosciences	8	264	2112
Cancer Research	9	206	1854
Biotechnology and Applied Microbiology	10	190	1900
Biophysics and Structural Biology	11	182	2002
Endocrinology and Metabolic Disorders	12	146	1752
Biological Research Methods	13	118	1534
Computational Biology and Bioinformatics	14	81	1134
Genetics and Heredity	15	75	1125
Gastrointestinal Disorders	16	73	1168
Library and Information Science	17	55	935
Inflammatory and Immunological Disorders	18	52	936
Nuclear Medicine	19	50	950
Toxicology - Arsenic	20	36	720
Other 18 area of research		224	5506

Zipf's law has not been found true in case of IICB as illustrated in table 5 & 6.

Conclusions

It is observed that IICB has been actively continuing its research on infectious diseases and published largely on Leishmania (12.35%) and Cholera (7.76%) i.e. 20.11% in total. A total of 12.35% of papers have been published on 'Leishmania' followed by Natural Products Chemistry with 10.36% and Biochemistry and Molecular Biology with 7.87% papers and so on which reflects the diversification of IICB research activities. There is no major change in research focus throughout the entire period but new disciplines of research have been added over the time and some areas have lost the importance as it was before to address the need.

Analysis further shows that the principal focus of research remain on infectious diseases like Leishmania & Cholera. Other areas like Natural Products Chemistry, Synthesis of New Chemical entities having significant biological activities, Cancer Research, Biotechnology and Applied Microbiology, Biophysics and Structural Biology, Computational Biology and Bioinformatics, Proteomics, genetics of disease susceptibility, Drug development and discovery, Inflammatory & Immunological Disorders, Neurobiology including development of new methods in modern biological research are also addressed in its research activities.

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